The Effect of Total Hip Arthroplasty on Clinical and Radiological Changes in the Sagittal Alignment of the Spine
(A Retrospective Study)

Abstract

Introduction: Hip osteoarthritis is a common condition affecting 10–15% of individuals over 60 years old, leading to significant pain and discomfort. Low back pain is also highly prevalent among the elderly. The hip-spine syndrome describes the relationship between spinal pain, hip disorders, and symptomatic changes following hip reconstruction surgeries, particularly total hip arthroplasty (THA). The impact of THA on the biomechanical structure of the spine and pelvis remains unclear. This study investigates changes in clinical and radiological sagittal spinal alignment parameters following THA.

Materials & Methods: This study included 15 patients who underwent THA at one hospital. Radiographic parameters (Sacral Slope, lumbar lordosis, and S1-L1 distance) and clinical parameters, including low back pain (PSFS questionnaire), daily activity level (PSEQ questionnaire), and hip flexion range of motion, were assessed before and three months after surgery.

Results & Discussion: Radiological changes after THA were not statistically significant. However, there was a significant reduction in low back pain (5.01±1.1-, P<0.001). An improvement in activity level (23.47±7.1, P<0.001), and an increase in hip flexion range of motion (38.66±19.62, P<0.001). Additionally, higher BMI was associated with a lower improvement in activity level (P=0.047).

Conclusion: THA leads to reduced low back pain, improved activity level, and increased hip flexion range of motion. However, these changes are not correlated with radiological sagittal alignment parameters.

Keywords: Total hip arthroplasty, Low back pain, Spine.

Accepted: 40 days before printing

Hamid Hesarikia, MD[1], Abas Hossein Por Azari, MD[1], Seyed Mahdi Hosseini Amir Abadi, MD[1], Mahdi Abbaszadeh, MD[1], Mohsen Motalebi, MD[1], Amir Hosein Ghazale, MD[1,2], Mohammad Ghalamfarsa, MD[2], Ali Reza Shakeri Sefat, MD[1], Mohammad Kazem Emami Meybodi, MD[1]

1. Trauma Research Center, Baqiyatallah University of Medical Sciences, Tehran, Iran.
2. Student Research Committee, Baqiyatallah University of Medical Sciences, Tehran, Iran.

Corresponding Author:
Mohammad Kazem Emami Meybodi, MD
Email address:
Dr.Mkemamimeybodi@gmail.com

Introduction

Hip osteoarthritis is one of the most common joint disorders in the elderly people, affecting approximately 10–15% of individuals over the age of 60 worldwide[(1)]. This condition not only causes severe pain and functional disability in the hip region, but is also frequently associated with lumbar spine pain. Low back pain is common in older adults and usually overlaps with hip joint disorders. The concurrent presentation of hip and spinal problems is referred to as the hip–spine syndrome, which is commonly observed following total hip arthroplasty (THA)[(2)].

THA is very effective treatment modalities for alleviating pain and improving function in patients with advanced degenerative hip disease. However, its impacts on the biomechanical structure of the hip and spine, and their association with pain and functional outcomes, remain incompletely understood. Previous studies have shown that postoperative changes, such as correction of deformities and release of adhesions, may influence sagittal spinal alignment and the function of periarticular hip musculature. These changes could potentially result in either improvement or exacerbation of low back pain and limitations in mobility[(3)].

Numerous studies have evaluated the effects of THA on patient pain and functional outcomes. Some have demonstrated that the alleviation of hip pain following THA may be accompanied by a reduction in low back pain[(4,5)].

Nevertheless, other investigations have reported contradictory findings regarding postoperative changes in spinal alignment following THA[6].

Furthermore, the relationship between radiographic changes in sagittal spinal alignment and low back pain after THA has not been thoroughly investigated. Certain studies have indicated that alterations in sacral slope and lumbar lordosis may influence patient outcomes. Evidence suggests that improvements in sagittal alignment could be associated with reduced low back pain and enhanced function[7,8]. Despite recent advances in THA techniques, considerable gaps persist in understanding the comprehensive effects of this surgery on pain and functional outcomes. Specifically, few studies have simultaneously assessed both clinical parameters (e.g., pain and function) and radiological parameters (e.g., sagittal spinal alignment) following THA. This issue is of particular importance, as a deeper understanding of these associations could optimize therapeutic strategies and improve patients' quality of life.

The primary objective of this study was to evaluate changes in clinical measures of low back pain and radiological sagittal spinal alignment following THA in patients with hip osteoarthritis. Specific objectives included assessing changes in sacral slope, lumbar lordosis, S1–L1 sagittal vertical axis, as well as clinical indices of pain and functional performance after surgery. By simultaneously investigating clinical and radiological changes, this study seeks to provide greater insight into the impact of THA on pain and patient function, ultimately offering more effective therapeutic approaches to enhance quality of life.

Materials & Methods

This descriptive retrospective study was conducted on 15 cases who were candidates for elective unilateral total hip arthroplasty (THA) at Baqiyatallah Hospital (Tehran, Iran) in 2018. The patients were recruited from the outpatient orthopedic clinic of the hospital. The sample size was determined based on similar studies; in cases where the desired sample size could not be achieved, the bootstrap method was applied, with a minimum sample size of 10 patients per group used for data analysis.

Patients were randomly selected using a random number table. The inclusion criteria consisted of standard indications for THA, as defined in Campbell's Operative Orthopaedics. The exclusion criteria included prior history of surgery on the hip joint or spine, neuromuscular disorders, history of fracture involving the hip or spine, active infection of the hip joint or elsewhere in the body, morbid obesity (BMI ≥ 40), and unwillingness to participate in the study. Patients who developed severe postoperative complications or required spinal interventions were also excluded.

Preoperative evaluations included laboratory tests—blood chemistry (electrolytes, CBC, renal function tests, fasting blood glucose, and HbA1C in diabetic patients) and urinalysis (analysis and culture)—performed according to standard protocols. Necessary consultations (cardiology, anesthesiology, and others as indicated) were obtained for all patients. Preoperative radiographic assessments included standing anteroposterior and lateral views of the pelvis and lumbosacral spine with bowel preparation. All THA procedures were performed by experienced hip surgeons at Baqiyatallah Hospital using either a lateral or anterolateral surgical approach. Postoperative care, including administration of antibiotics, anticoagulants, analgesics, physiotherapy, and patient education, was standardized across all patients. Follow-up assessments were scheduled for two weeks and then three months after surgery. At each visit, the Patient-Specific Functional Scale (PSFS) and Pain Self-Efficacy Questionnaire (PSEQ) were completed, and hip flexion range of motion was measured. Radiographs of the pelvis and spine were also obtained at these time points. Data analysis was conducted using SPSS software (version 19; IBM Corp., Armonk, NY, USA). Descriptive statistics were used for radiological, pain, and functional measures. Paired t-tests were applied to compare preoperative and postoperative mean values. Correlation and regression analyses were performed to examine associations between demographic variables (age, BMI, and sex) and radiological or functional parameters.

This study was conducted in accordance with the Declaration of Helsinki and approved by the Research Ethics Committee of Baqiyatallah University of Medical Sciences (ethics code: IR.BMSU.REC.1397.012). Informed consent was obtained from all participants, and their personal information was kept confidential. In total, 15 patients undergoing THA at Baqiyatallah Hospital were evaluated with respect to radiological parameters of sagittal spinal alignment, clinical indices of pain and daily activity, and hip flexion range

of motion, both preoperatively and three months postoperatively.

Results

In this study, the mean age was 63.27 ± 7.41 years (45-76 years), 8 patients (53.3%) were female and 7 (46.7%) were male and the mean body mass index (BMI) was 24.15 ± 2.28 (20.86 - 29.48).

The radiological parameters of sagittal spinal alignment were assessed preoperative and postoperative. Using the Paired Samples Test, pre- and postoperative values of sagittal alignment parameters were compared (Table 1). As presented in Table 1, the mean values of sacral slope and lumbar lordosis increased following surgery, whereas the S1–L1 sagittal vertical axis decreased. However, none of these changes reached statistical significance.

The scores of the Patient-Specific Functional Scale (PSFS), the Pain Self-Efficacy Questionnaire (PSEQ), and hip flexion range of motion (Hip ROM) were also assessed before and after surgery. Using the Paired Samples Test, pre- and postoperative values were compared (Table 2). As presented in Table 2, the mean PSEQ score increased after surgery, while the mean PSFS score decreased. In addition, hip flexion ROM increased by a mean of 38.66 degrees postoperatively. All three of these changes were statistically significant ($P < 0.001$).

Correlation analyses were then performed between quantitative independent variables (BMI and age) and the changes in radiological and clinical parameters. The following statistically significant associations were identified, while no other correlations reached statistical significance:

- Age and changes in lumbar lordosis demonstrated a significant positive correlation (Pearson's $r = 0.58$, $p = 0.024$).
- BMI and changes in PSEQ showed a significant negative correlation (Pearson's $r = –0.52$, $p = 0.047$).
- Changes in sacral slope and lumbar lordosis were significantly positively correlated (Pearson's $r = 0.60$, $p = 0.019$).

The mean and standard deviation of changes in sacral slope, lumbar lordosis, S1–L1 sagittal vertical axis, PSEQ scores, PSFS scores, and hip flexion ROM in male and female subgroups are presented in Table 3. In the comparison between male and female groups using the Bootstrap Independent Samples t-test, the only statistically significant difference was in changes in sacral slope (Mean Difference = 12.14, $p = 0.008$).

Table 1: Mean and standard deviation of sacral slope, lumbar lordosis, and S1–L1 sagittal vertical axis before and after surgery.

Variable	Pre-operative (Mean ± SD)	Post-oprerative (Mean ± SD)	P value	t SD
Sacral slope (°)	42.36 ± 3.68	44.19 ± 7.19	0.435	0.804
Lumbar lordosis (°)	40.76 ± 4.65	42.74 ± 11.29	0.531	0.642
S1–L1 sagittal vertical axis (mm)	27.81 ± 13.95	26.15 ± 12.06	0.618	0.510

Table 2: The scores of Patient-Specific Functional Scale (PSFS), Pain Self-Efficacy Questionnaire (PSEQ), and hip flexion range of motion (Hip ROM) before and after surgery.

Variable	Preoperative (Mean ± SD)	Postoperative (Mean ± SD)	P value	Mean Difference ± SD
PSEQ	23.13 ± 4.97	46.60 ± 6.10	<0.001	12.81
PSFS	7.47 ± 1.06	2.40 ± 1.12	<0.001	-17.84
Hip ROM	67.56 ± 20.67	94.67 ± 11.25	<0.001	7.50

Table 3: Mean and standard deviation of sacral slope changes, lumbar lordosis, S1-L1 axis distance, mean PSEQ changes, mean PSFS changes, and mean Hip ROM changes in the two groups of men and women.

Variable	Female (Mean ± SD)	Male (Mean ± SD)
Sacral slope change (°)	–7.55 ± 7.29	4.59 ± 6.23
Lumbar lordosis change (°)	–4.52 ± 15.34	9.29 ± 6.34
S1–L1 sagittal vertical axis change (mm)	–11.1 ± 16.12	4.81 ± 6.80
PSEQ score change	25.37 ± 8.84	21.29 ± 3.99
PSFS score change	–4.87 ± 1.25	–5.29 ± 0.95
Hip ROM change (°)	31.87 ± 19.44	45.0 ± 18.7

Discussion

This study was conducted to evaluate changes in clinical and radiological parameters of sagittal spinal alignment following total hip arthroplasty (THA) at Baqiyatallah Hospital in 2018. The results showed that mean changes in sacral slope (9.08 ± 1.89°), lumbar lordosis (1.95 ± 1.98°), and S1–L1 sagittal vertical axis (–12.61 ± 1.66 mm) were not statistically significant. These findings are consistent with those of Radcliff and Ayazov, who also reported no significant changes in sagittal alignment after THA[9,10].

Low back pain was evaluated using the PSFS questionnaire. The mean change was –5.01 ± 1.1 out of 10 points, which was statistically significant ($P < 0.001$) and reflected a reduction in patient pain scores from 7.47 to 2.4. Similar findings were reported by Ben-Galim (reduction from 5.40 to 3.68) and Ayazov (reduction from 6 to 3)[5,10]. Differences in the magnitude of pain reduction among studies may be attributed to the subjective nature of pain measurement as well as cultural and ethnic variations.

Improvement in patient function after surgery was assessed using the PSEQ. The mean change was 23.47 ± 7.1 out of 60 points, which was statistically significant ($P < 0.001$), showing an improvement from 23.13 to 46.6. In the study by Ayazov, the mean SF-36 score increased from 34 to 47 ($P < 0.001$). That study also found that improvements in low back pain were not significantly associated with changes in sagittal alignment[10]. Similarly, Ben-Galim reported increased functional capacity following THA, consistent with our findings[5].

Assessment of hip flexion ROM demonstrated an increase from 67.56° to 67.94°, with a mean change of 38.66 ± 19.62°, which was statistically significant ($P < 0.001$). Prior studies have reported mixed results in this regard; some described reductions in hip ROM, whereas others observed improvements[11,12]. However, the meta-analysis by Awan confirmed increased hip flexion ROM following THA[3], which aligns with our results. Variations in findings across studies may be related to differences in surgical technique, surgical approach, and the extent of periarticular contracture release.

A significant negative correlation was found between BMI and PSEQ changes (Pearson's $r = –0.52$, $p = 0.047$), indicating that higher BMI was associated with reduced functional improvement after surgery. These findings were compatible with Dutch cohort study involving 2,400 THA cases[13].

Overall, this study demonstrated that despite the lack of significant radiological changes in sagittal spinal and pelvic alignment, patients experienced substantial improvements in low back pain and function following THA, along with a marked increase in hip flexion ROM. Furthermore, functional improvement was inversely related to BMI, suggesting that preoperative weight reduction could contribute to improved postoperative outcomes.

These findings reinforce a well-recognized principle in orthopedics—that corrective spinal surgery should precede hip arthroplasty in cases requiring both interventions. Given the inclusion and exclusion criteria applied in this study, our patients had relatively preserved sagittal alignment preoperatively due to screening for severe spinal disorders, and their predominant symptom was low back pain. After THA, significant pain relief was achieved, suggesting that the source of pain was the effect of hip osteoarthritis on the spine rather than primary spinal pathology. Conversely, advanced hip osteoarthritis appeared to exert only a minor influence on sagittal alignment, which may explain the absence of significant radiological changes.

This study addresses a novel area by simultaneously investigating clinical and radiological changes, despite the heterogeneous results of previous research.

The present findings may guide future studies and assist in the clinical evaluation of patients after THA, contributing to the development of more effective therapeutic strategies. Meanwhile, limitations in our study were: relatively small sample size, increasing the number of participants could yield more robust results. In addition, although a three-month follow-up period is reasonable for evaluating sagittal alignment changes, such changes may also occur over longer intervals, necessitating extended follow-up. Accordingly, future studies should focus on patients with more severe hip deformities (such as developmental dysplasia of the hip), bilateral osteoarthritis, and those undergoing bilateral THA. Moreover, the use of advanced imaging modalities such as EOS, combined with longer-term follow-up, could provide deeper insights into structural and functional changes in these patients.

Conclusion

Total hip replacement reduces back pain, improves function, and increases hip flexion range of motion, but these changes are not associated with sagittal radiological measures.

References

1 Ishimoto Y, Yoshimura N, Muraki S, Yamada H, Nagata K, Hashizume H, et al. Prevalence of symptomatic lumbar spinal stenosis and its association with physical performance in a population-based cohort in Japan: the Wakayama Spine Study. Osteoarthritis Cartilage. 2012;20(10):1103-1108. doi: 10.1016/j.joca.2012.06.018

2 Prather H, van Dillen L. Links between the Hip and the Lumbar Spine (Hip Spine Syndrome) as they Relate to Clinical Decision Making for Patients with Lumbopelvic Pain. Pm r. 2019;11 Suppl 1:S64-S72. doi: 10.1002/pmrj.12187

3 Ewen AM, Stewart S, St Clair Gibson A, Kashyap SN, Caplan N. Post-operative gait analysis in total hip replacement patients-a review of current literature and meta-analysis. Gait Posture. 2012;36(1):1-6. doi: 10.1016/j.gaitpost.2011.12.024

4 Weng W, Wu H, Wu M, Zhu Y, Qiu Y, Wang W. The effect of total hip arthroplasty on sagittal spinal–pelvic–leg alignment and low back pain in patients with severe hip osteoarthritis. European Spine Journal. 2016;25(11):3608-3614. doi: 10.1007/s00586-016-4444-1

5 Ben-Galim P, Ben-Galim T, Rand N, Haim A, Hipp J, Dekel S, et al. Hip-spine syndrome: the effect of total hip replacement surgery on low back pain in severe osteoarthritis of the hip. Spine (Phila Pa 1976). 2007;32(19):2099-2102. doi: 10.1097/BRS.0b013e318145a3c5

6 Rajnish RK, Kumar P, Aggarwal S. Letter to the Editor concerning “The effect of total hip arthroplasty on sagittal spinal–pelvic–leg alignment and low back pain in patients with severe hip osteoarthritis” by W. Weng et al. Eur Spine J (2016);25(11):3608–3614. European Spine Journal. 2017;26(8):2211. doi: 10.1007/s00586-017-5137-0

7 Liow MHL, Goh GS-H, Chua JL, Ling ZM, Soh RCC, Guo C-M, et al. Sagittally Balanced Degenerative Spondylolisthesis Patients With Increased Sacral Slope and Greater Lumbar Lordosis Experience Less Back Pain After Short-Segment Lumbar Fusion Surgery. Clinical Spine Surgery. 2020;33(5):E231-E235. doi: 10.1097/bsd.0000000000000923

8 Kim DY, Moon ES, Park JO, Chong HS, Lee HM, Moon SH, et al. The Thoracic Lordosis Correction Improves Sacral Slope and Walking Ability in Neuromuscular Scoliosis. Clinical Spine Surgery. 2016;29(8):E413-E420. doi: 10.1097/BSD.0b013e318294368e

9 Radcliff KE, Orozco F, Molby N, Delasotta L, Chen E, Post Z, et al. Change in spinal alignment after total hip arthroplasty. Orthop Surg. 2013;5(4):261-265. doi: 10.1111/os.12076

10 Eyvazov K, Eyvazov B, Basar S, Nasto LA, Kanatli U. Effects of total hip arthroplasty on spinal sagittal alignment and static balance: a prospective study on 28 patients. Eur Spine J. 2016;25(11):3615-3621. doi: 10.1007/s00586-016-4696-9

11 Bennett D, Humphreys L, O'Brien S, Kelly C, Orr JF, Beverland DE. Gait kinematics of age-stratified hip replacement patients-a large scale, long-term follow-up study. Gait Posture. 2008;28(2):194-200. doi: 10.1016/j.gaitpost.2007.11.010

12 Bahl JS, Nelson MJ, Taylor M, Solomon LB, Arnold JB, Thewlis D. Biomechanical changes and recovery of gait function after total hip arthroplasty for osteoarthritis: a systematic review and meta-analysis. Osteoarthritis Cartilage. 2018;26(7):847-863. doi: 10.1016/j.joca.2018.02.897

13 Hofstede SN, Gademan MGJ, Stijnen T, Nelissen R, Marang-van de Mheen PJ. The influence of preoperative determinants on quality of life, functioning and pain after total knee and hip replacement: a pooled analysis of Dutch cohorts. BMC Musculoskelet Disord. 2018;19(1):68. doi: 10.1186/s12891-018-1991-0